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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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VACUUM STABILITY REQUIREMENTS OF POLYMERIC MATERIAL FOR SPACECRAFT APPLICATION

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VACUUM STABILITY REQUIREMENTS OF POLYMERIC MATERIAL FOR SPACECRAFT APPLICATION

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1.0 PURPOSE

The purpose of this document is to establish requirements and test guidelines for polymeric material used in space thermal/vacuum atmosphere around sensitive optical equipment.

2.0 REQUIREMENTS

The control and verification of material and assembly outgassing to the guidelines of this document are based on the following requirements:

a. The polymeric materials used in the thermal/vacuum atmosphere shall not contaminate the optical equipment in that assembly.

b. The polymeric materials used in any application shall not affect the optic system at any adjacent equipment.

The materials shall have a maximum weight loss of 1.0 percent and a volatile condensable material (VCM) content of 0.1 percent when tested in accordance with the test procedure in paragraph 7.

3.0 SCOPE

The scope of this document covers the control of polymeric materials used near or adjacent to optical equipment that are exposed to the thermal vacuum atmosphere of space. This document establishes the requirements and defines the test method to evaluate polymeric materials used in the vicinity of optical surfaces in space applications. This document should not be used for evaluation of material applications inside the pressurized area of a spacecraft or materials used inside any hermetically sealed container.

4.0 SELECTION AND VERIFICATION REQUIREMENTS

Use of polymeric material near optical equipment shall be restricted to those materials which have a maximum volatile condensable material (VCM) of 0.1

percent and a total weight loss of 1.0 percent when tested in accordance with the test method described in paragraph 7. NASA/MSC SED (Systems Engineering Division) will provide the contractor a list of approved materials for use in vacuum atmosphere, upon request. NASA/MSC/SED also maintains a complete file of all material tested.

The use of materials that have been tested but failed the requirements of this specification may be used if the contractor can provide rationale for its use that is approved by NASA/MSC/SED. The following are examples of some considerations for use as rationale for a material that has failed the VCM and weight loss requirements:

a. The material is the best available for the particular application.

b. The quantity and surface area of the material is small, and not in the immediate vicinity of an optic system.

c. The material may be vacuum cured for additional time.

5.0 IMPLEMENTATION

The contractor shall provide for NASA/MSC/SED approval, a list of all polymeric materials selected for use around optical equipment or in the same defined compartment as optical equipment. The following information is required:

a. Manufacturer's trade name

b. Manufacturer of the material

c. Volatility condensible material (VCM test data)

d. Rationale for use of material that failed the requirements of paragraph 4.0.

6.0 QUALITY ASSURANCE REQUIREMENTS

The Quality Assurance requirements for the test in paragraph 7 are as follows:

6.1 All instrumentation utilized in this test shall be in current calibration and shall bear appropriate documentation to this effect from an approved calibration laboratory.

6.2 All materials tested shall have tracability equivalent to that required for materials used in the construction of flight hardware.

6.3 Test laboratories involved in testing to the requirements of this document shall be certified as to competency by conducting tests of standard materials under step-by-step Quality Assurance surveillance. Such certification shall be required yearly.

6.4 Upon completion of tests, test engineers shall certify that all required procedures were followed and that the results reported are correct.

6.5 At random intervals (not to exceed three months) Quality Assurance shall observe selected portions of all procedures to verify routine conformance to test procedures.

6.6 Daily surveillance, or step-by-step Quality Assurance sign-off on procedures, is not required.

7.0 TEST PROCEDURE

7.1 Purpose

The purpose of this test is to measure weight loss and volatile condensible materials (VCM) content of polymeric materials under controlled laboratory conditions.

7.2 Test Conditions

The test on polymeric materials shall be conducted under the following conditions:

Pressure	10^{-6} TORR or Less
Temperature of specimen	125°C ± 1°C
Temperature of condensible plates	25°C ± 1°C
Vacuum exposure time	24 hours

7.3 Test Discipline

7.3.1 Each test shall be directed by the cognizant test engineer or his appointed alternate.

7.3.2 The cognizant test engineer shall affix his signature to all test data sheets and verify adequacy of identification information.

7.4 Criteria of Acceptability

The materials shall have a volatile condensible material (VCM) content of less than 0.1 percent by weight. The total weight loss of the material shall not exceed 1.0 percent by weight.

7.5 Test Equipment

The test equipment shall consist of the following:

7.5.1 A vacuum system capable of maintaining 10^{-6}TORR for a period of 24 hours.

7.5.2 Sample holder made of stainless steel crucibles (see figure 1). The sample holder shall be nominally 1 1/2 inches long and 1/2 inch in diameter.

7.5.3 Collector plate (see figure 2) shall be made of copper. The collector plate shall be 1 1/2 inches in diameter.

7.5.4 The test apparatus shall be made of copper. The apparatus shall be such that at least four sample holders and collector plates can be accommodated at one time. The sample section

shall be capable of maintaining the samples at 125°C and maintaining the collector plates at 25°C. The test equipment shall be constructed in the general manner described in Figure 3, which is a section down the middle of the apparatus. Figure 3A shows a cross section of the apparatus of a sample holder. Figure 3B shows a typical arrangement of the standoff's used for the heating chamber and the baffles. The baffle construction is shown in Figure 4.

7.5.5 A balance that is capable of weighing one (1) micro gram.

7.6 Sample Preparation

7.6.1 Materials to be tested shall be prepared in 100 to 200 milligram sample sizes and placed in stainless steel holders after preparation as specified below:

7.6.1.1 Solid Materials: Specimens shall be cut into small pieces having 1/16 maximum dimension. Samples shall be placed in a desiccator after preparation, and remain there until the samples are placed in the test chamber.

7.6.1.2 Coatings: Materials that are normally used as coatings shall be applied to stainless steel screen. Coating procedure shall be specified in the request for test. One-hundred mesh, or finer, screen shall be used.

7.6.1.3 Liquids: Oils and viscous liquids shall be absorbed into Refrasil A-100 batting that is free from any volatile residues.

7.6.2 All material shall be cured or applied in accordance with the manufacturer's procedures or the applicable contractor process specification prior to test.

7.7 Pre-test Procedure

7.7.1 Verify that all test equipment is in current calibration.

7.7.2 Verify material identification by one of the following:

7.7.2.1 Manufacturer's certification

7.7.3.1 NASA certification

7.7.3.3 Contractor certification

7.7.3 Prepare sample in accordance with paragraph 6.0.

7.7.4 The sample holder shall be thoroughly cleaned prior to use.

7.7.5 The collector plates shall be cleaned and polished prior to installation in the apparatus.

7.7.6 Extreme care shall be taken to prevent contamination of specimens or exposed portions of the test apparatus with any organic oils, residue, etc.

7.7.7 Identify each sample in the apparatus.

7.7.8 Each run shall contain one standard sample for calibration purposes. This sample shall be one of known weight loss and VCM.

7.8 Test Procedure

7.8.1 Initial Weight Determination: The VCM collector plates, the stainless steel holders used for sample holding and the stainless steel wire screens, and Refrasil A-100 batting used for preparation of coating and liquid material samples shall be preweighed. Samples in the stainless steel holders shall be stored in a desiccator prior to weighing.

7.8.2 Samples shall be weighed and recorded and placed in the desiccator until they are placed in the VCM apparatus.

7.8.3 The weighed samples shall be placed in the compartments of the heating blocks and the VCM collector plates shall be fastened to the cooling block of the apparatus.

7.8.4 The system shall be evacuated and held at a maximum pressure of 10^{-6}TORR.

7.8.5 When the unit has reached 10^{-6}TORR, the samples shall be heated to 125°C ± 1°C, and maintained for 24 hours. The VCM collector plates shall be maintained at 25°C ± 1°C during the test.

7.8.6 At the end of the 24-hour heating period, the heater blocks shall be cooled to 50°C and the vacuum chamber purged with dry nitrogen gas for 10 minutes.

7.8.7 The samples in their holders and the VCM collector plates shall be removed from the apparatus and immediately placed in a desiccator.

7.8.8 Weigh the samples and the collector plates as soon as possible after removal from the VCM apparatus, and record these weights.

7.8.9 All weights shall be determined to the nearest one (1) micro gram.

7.9 Reporting

7.9.1 All reports shall contain the following information:

7.9.1.1 Name of material

7.9.1.2 Vendor designation and vendor

7.9.1.3 Cure condition of the sample.

7.9.1.4 VCM content to the nearest 0.01 percent based on the original weight of the sample

7.9.1.5 Total weight loss to the nearest 0.01 percent based on the original weight loss of the sample

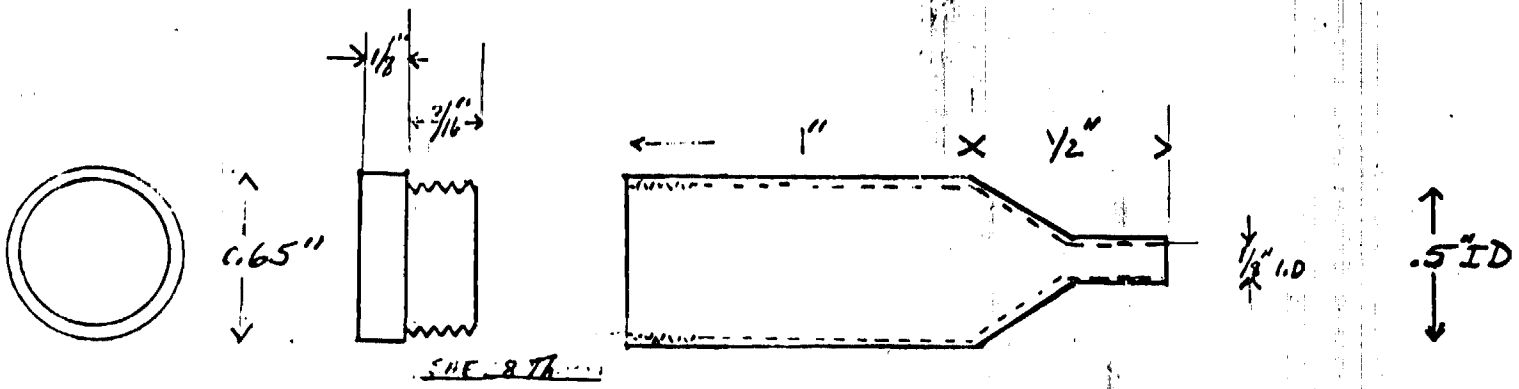
7.9.1.6 Date of test

7.9.1.7 Test number

7.9.1.8 Identity of testing organization

7.9.1.9 Name of test coordinator

7.9.1.10 Name and signature of test engineer



SAMPLE HOLDER CAP

SAMPLE HOLDER

Material - Stainless Steel
Tolerances - Nominal

FIGURE I - STAINLESS STEEL SAMPLE HOLDER

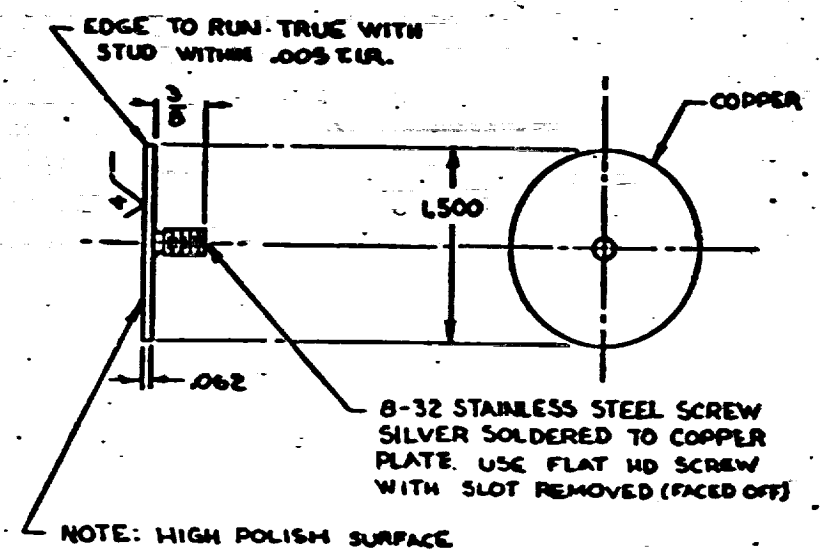


FIGURE 2 Copper Collector Plate

Figures 2 and 3 were extracted from "Polymers for Spacecraft Applications" by R. F. Muraca, et al., Stanford Research Institute.

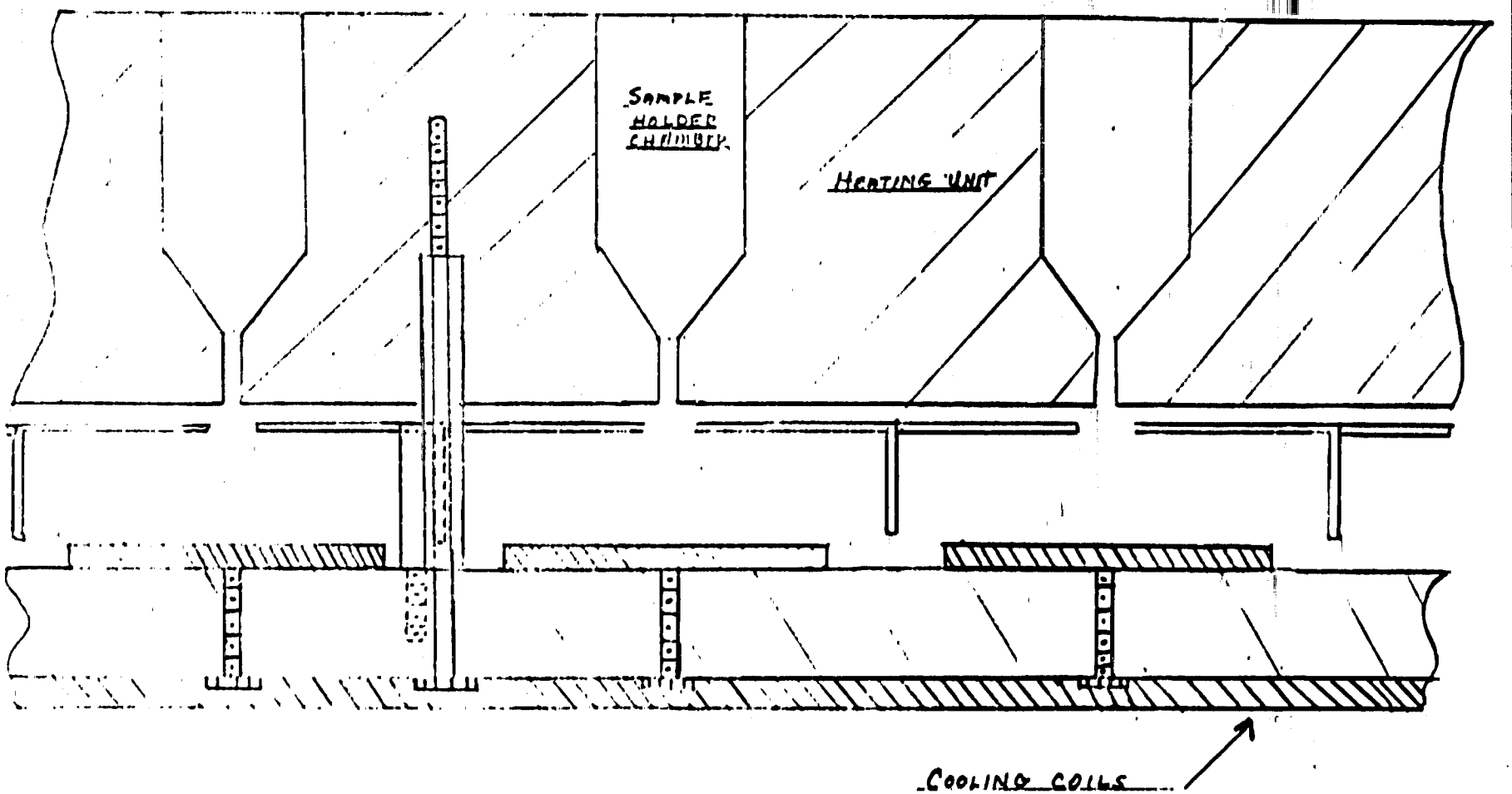


FIGURE 3 - Typical Section of the Assembled Apparatus

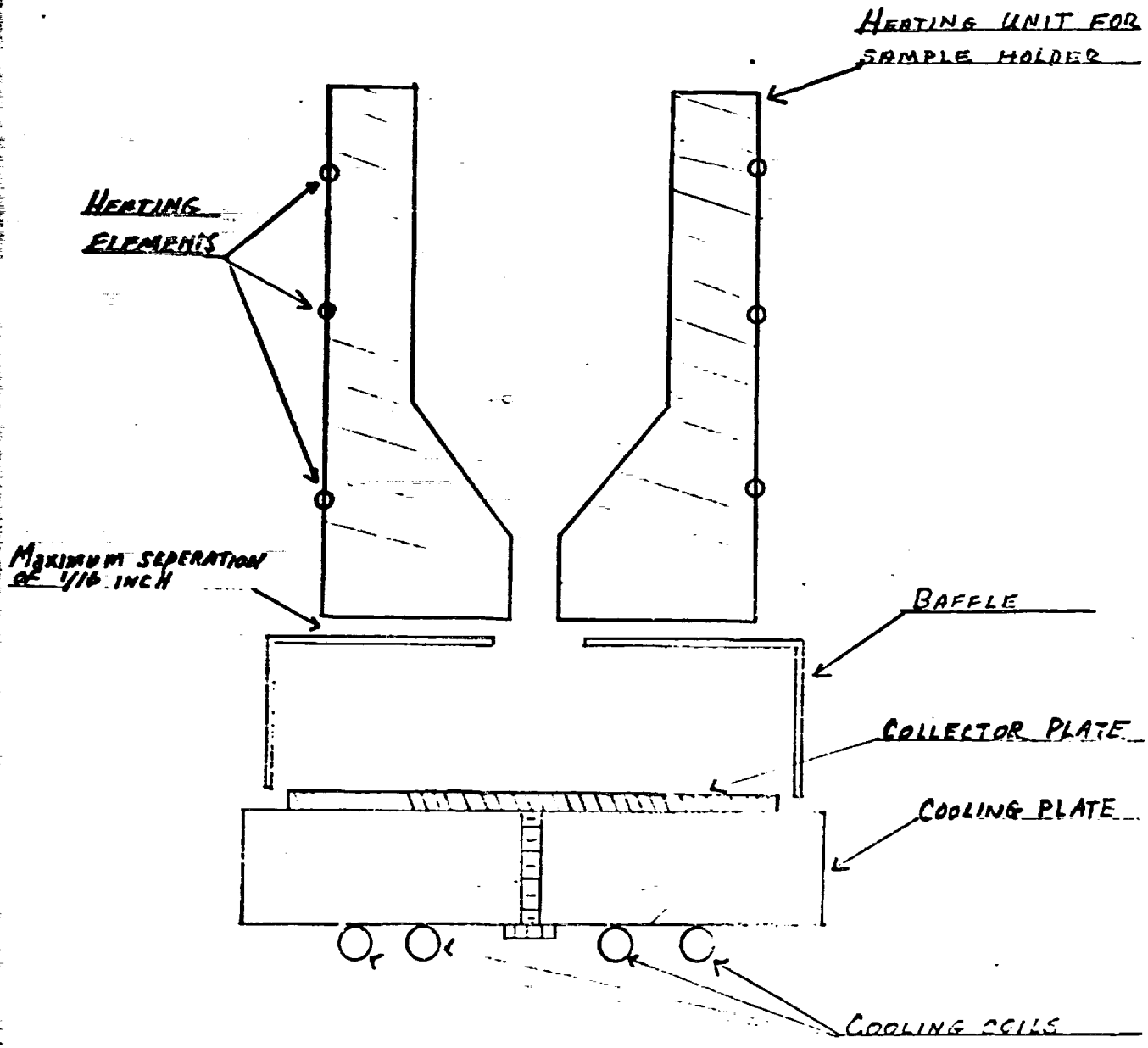


FIGURE 3A - Typical Cross Section of the Apparatus of a Sample Holder

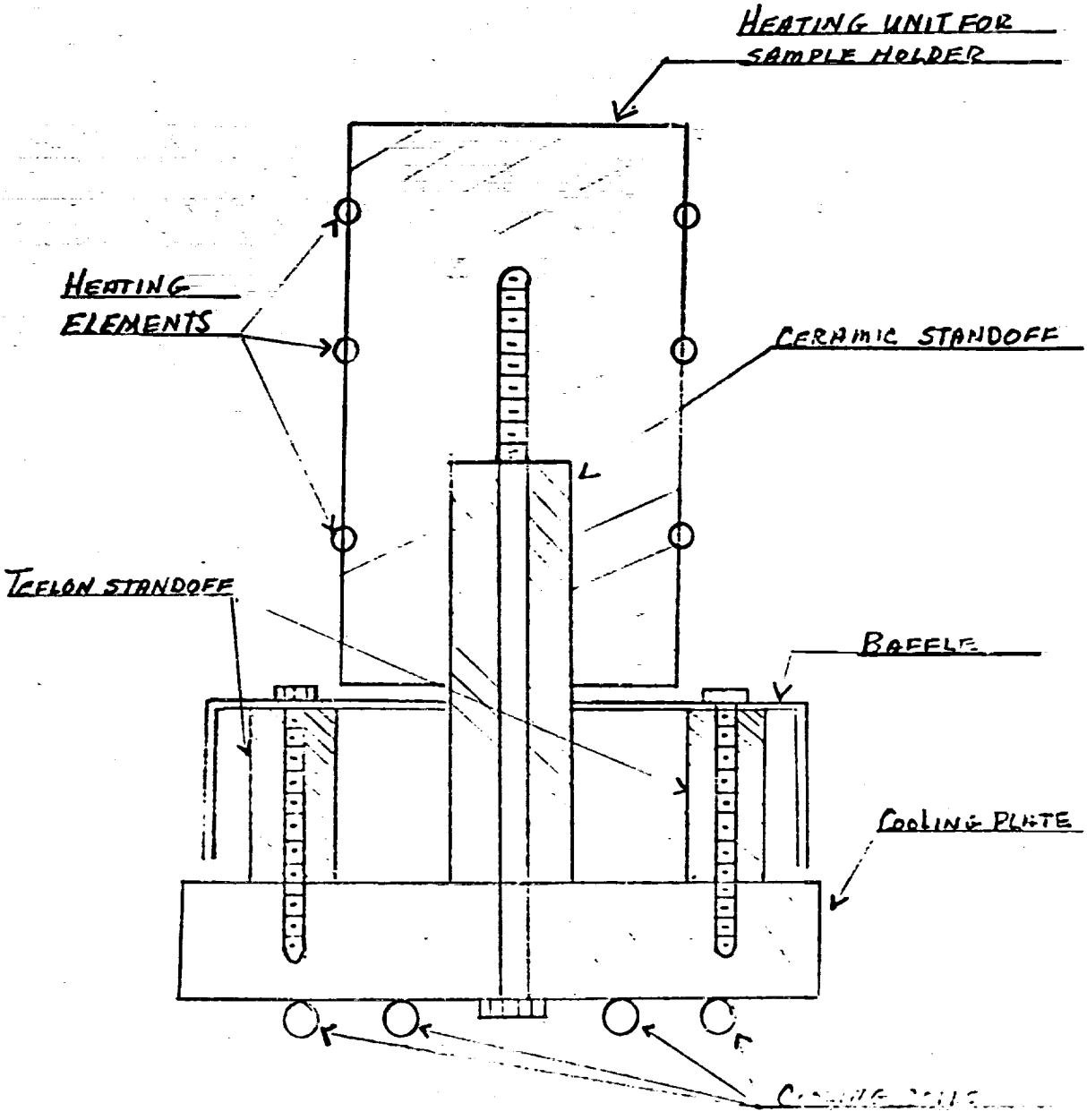
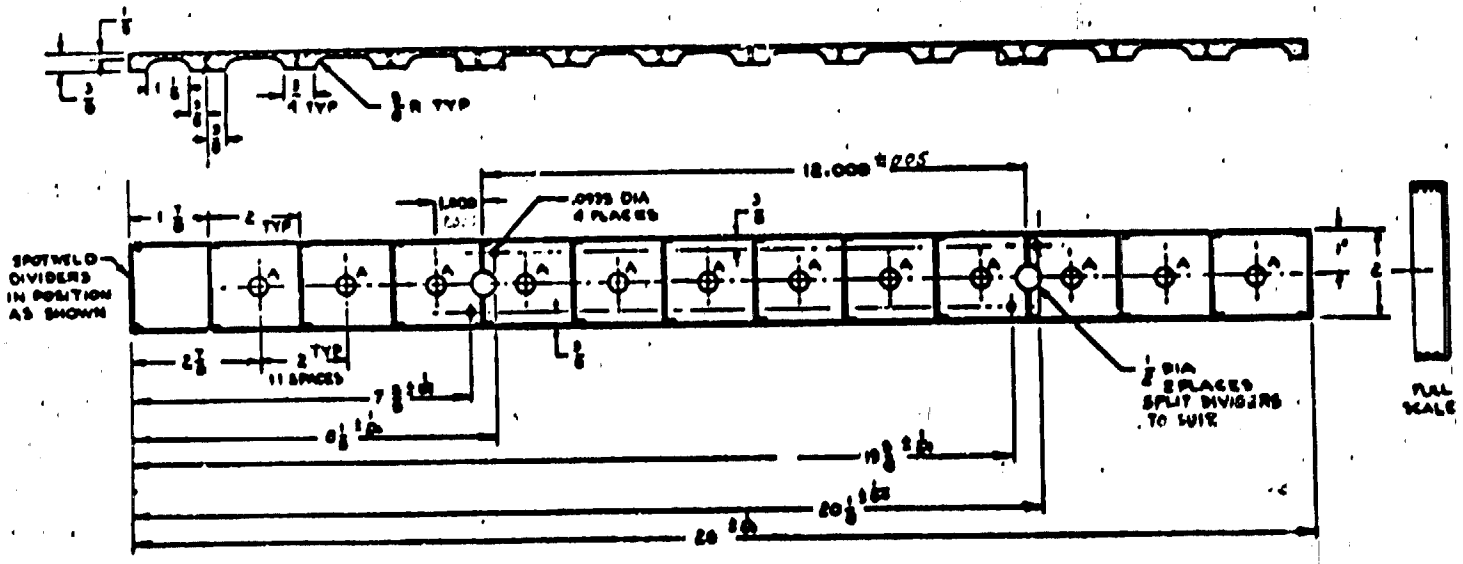


FIGURE 3B - TYPICAL CROSS SECTION AT THE STANDOFF'S OF THE APPARATUS



Material - .032" Stainless Steel

Tolerances - Nominal

FIGURE 4 Typical 12 Sample Baffle Plate